PATENT ABSTRACTS OF JAPAN

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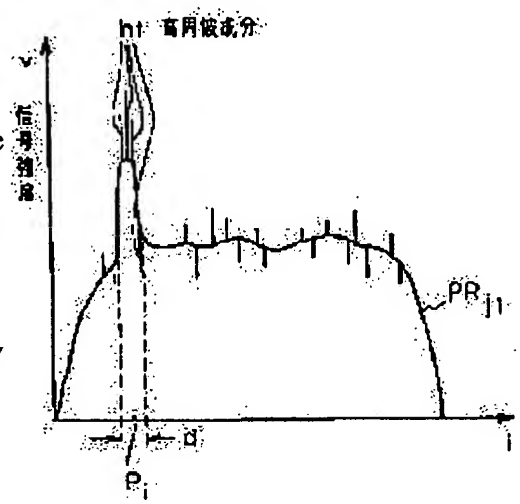
(54) METHOD AND DEVICE FOR CORRECTION PROJECTION AND RADIATION TOMOGRAPHY APPARATUS

(57)Abstract:
PROBLEM TO BE SOLVED: To remove a streak artifact by means of an object with a high radiation absorption rate by correcting the high frequency component of a projection at a specified corresponding position on the projection of several views concerning the image of the high radiation absorbing object of a tomographic image which is re-constituted from the projection.
SOLUTION: When the projection PRj1 in the view j1 is the one in a figure, for example, and a sinogram SN, that is the projection of the object is positioned at Pi on an i-axis, correction is executed concerning a prescribed range (d) including the position Pi. A corresponding position is correctly specified concerning the position Pi by utilizing the sinogram. At the time of correction, signals are made to be the ones only with the high frequency component by processing the projection PRj1 by a proper high-pass filter, a signal strength in each high frequency component belonging to the range (d) among them is obtained and subtraction is executed in the strengths which correspond in position in the projection PRi1. Thus, the high frequency components of the range (d) are cancelled.



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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the equipment of an example of the gestalt of operation of this invention.
[Drawing 2] It is the typical block diagram of the detector array in the equipment of an example of the gestalt of operation of this invention.
[Drawing 3] It is the typical block diagram of the X-ray irradiation and detection equipment in the equipment of an example of the gestalt of operation of this invention.
[Drawing 4] It is the typical block diagram of the X-ray irradiation and detection equipment in the equipment of an example of the gestalt of operation of this invention.
[Drawing 5] It is the mimetic diagram of the view channel space in the equipment of an example of the gestalt of operation of this invention.
[Drawing 6] It is the mimetic diagram of the tomogram photoed with the equipment of an example of the gestalt of operation of this invention.
[Drawing 7] It is flow drawing of actuation of the equipment of an example of the gestalt of operation of this invention.
[Drawing 8] It is the mimetic diagram of the binary image generated with the equipment of an example of the gestalt of operation of this invention.
[Drawing 9] It is the mimetic diagram of the sinogram generation by the equipment of an example of the gestalt of operation of this invention.
[Drawing 10] It is the mimetic diagram of the sinogram generated with the equipment of an example of the gestalt of operation of this invention.
[Drawing 11] It is the mimetic diagram of the projection of the analyte for which it asked with the equipment of an example of the gestalt of operation of this invention.
[Drawing 12] It is the mimetic diagram of the high frequency component of the projection of the analyte for which it asked with the equipment of an example of the gestalt of operation of this invention.
[Drawing 13] It is the mimetic diagram of the tomogram generated with the equipment of an example of the gestalt of operation of this invention.
[Description of Notations]
2 Scan Gantry
20 X-ray Tube
22 Collimator
24 Detector Array
26 Data Collection Section
28 X-ray Controller
30 Collimator Controller
32 Rotation Section
34 Rotation Controller
4 Photography Table
6 Actuation Console
60 Central Processing Unit
62 Control Interface
64 Capture Buffer
66 Storage
68 Display
70 Operating Set
40 X-ray Beam
8 Analyte
24 (i) X-ray sensing element

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Especially this invention relates to the radiation tomographic equipment which equipped with such a compensator the projection amendment method which amends the high frequency component of a projection about radiation tomographic equipment in the projection amendment method and an equipment list and equipment, and a list.
[0002]
[Description of the Prior Art] As an example of radiation tomographic equipment, there is for example, X-ray CT (computed tomography) equipment. In an X-ray CT scanner, an X-ray is used as radiation. An X-ray tube is used for X-ray generating.
[0003] The X-ray irradiation equipment containing an X-ray tube irradiates the X-ray beam (beam) which has thickness in the direction perpendicular to it with the width of face which includes photographic coverage. The thickness of an X-ray beam can be changed now by adjusting the opening of the X-ray passage opening (aperture: aperture) of a collimator (collimator), and can adjust the slice (slice) thickness of photography now by this.
[0004] X-ray detection equipment has the X-ray detector of the many channels (channel) which arranged many (for example, about 1000 pieces) X-ray sensing elements in the shape of an array (array) in the width-of-face direction of an X-ray beam, and detects an X-ray by it.
[0005] X-ray irradiation and detection equipment are rotated around analyte (scan: scan), the projection image (projection: projection) of the analyte by the X-ray is measured in two or more directions of a view (view) around analyte, respectively, and a tomogram is generated based on these projections (reconstruction).
[0006] For example, like the axial slice (axial slice) containing both shoulders, when the radioparency path within analyte photos a long slice, the high frequency component accompanying decrease of X-ray intensity comes to be contained in a projection, and the false image of the shape of a straight line called the streak artifact (streak artifact) to a reconstruction image by it arises. In order to control the streak artifact, data correction which reduces the high frequency component contained in a projection is performed.
[0007]
[Problem(s) to be Solved by the Invention] Since the data correction which reduces a high frequency component as mentioned above was accompanied by the side effect which is not desirable that the sharpness of a reconstruction image is reduced when the reduction degree was enlarged, it needed to reduce the high frequency component to the degree to which sharpness of an image is not reduced. For this reason, the strong streak artifact which originates in a body with high rates of X-ray absorption, such as an in-the-living-body embedding metal and a bone, for example had the problem referred to as fully being unable to control.
[0008] Made in order that this invention might solve the above-mentioned trouble, the purpose is realizing radiation tomographic equipment which equipped with such a compensator the projection amendment method of removing the streak artifact by the body with the high rate of the absorption of radiation and equipment, and a list.
[0009]
[Means for Solving the Problem] (1) The 1st invention which solves the above-mentioned technical problem is the projection amendment method characterized by what a correspondence location on a projection of the aforementioned two or more views is pinpointed, respectively per image of a radiation high absorber in a tomogram reconfigurated from a projection of two or more views by radiation, and a high frequency component of said projection in said correspondence location is amended for.
[0010] (2) The 2nd invention which solves the above-mentioned technical problem is a projection compensator characterized by to provide a location specification means to pinpoint a correspondence location on a projection of the aforementioned two or more views, respectively per image of a radiation

high absorber in a tomogram reconfigurated from a projection of two or more views by radiation, and a data correction means amend a high frequency component of said projection in said correspondence location.
[0011] (3) The 3rd invention which solves the above-mentioned technical problem is radiation tomographic equipment which collects projections of two or more views by radiation, and generates a tomogram based on it. A location specification means to pinpoint a correspondence location on a projection of the aforementioned two or more views per image of a radiation high absorber in said tomogram, respectively, It is the radiation tomographic equipment characterized by providing a data correction means to amend a high frequency component of said projection in said correspondence location, and an image reconstruction means to reconfigurate a tomogram based on a projection of two or more views which said data correction means amended.
[0012] In any one of the 1st invention thru/or the 3rd invention, it is desirable to perform pinpointing of said correspondence location based on sinogram of said radiation high absorber in view channel space at a point of performing location specification with a sufficient precision.
[0013] (Operation) In this invention, data correction about a high frequency component of a projection is performed in a correspondence location of a radiation high absorber for which it asked from a tomogram.
[0014]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to details with reference to a drawing. In addition, this invention is not limited to the gestalt of operation. Block (block) drawing of an X-ray CT scanner is shown in drawing 1 . This equipment is an example of the gestalt of operation of the radiation tomographic equipment of this invention. An example of the gestalt of the operation about the equipment of this invention is shown by the configuration of this equipment. An example of the gestalt of the operation about the method of this invention is shown by actuation of this equipment.
[0015] This equipment is equipped with the scan gantry (gantry) 2, the photography table (table) 4, and the actuation console (console) 6 as shown in drawing 1 . The scan gantry 2 has X-ray tube 20 as the radiation source. The X-ray which was emitted from X-ray tube 20 and which is not illustrated is fabricated so that it may become a flabellate form X-ray beam (fan beam), i.e., a fan beam, with a collimator 22, and it is irradiated by the detector array 24. The detector array 24 has two or more X-ray sensing elements arranged in the shape of an array in the width-of-face direction of a flabellate form X-ray beam. The configuration of the detector array 24 is explained anew later. X-ray tube 20, a collimator 22, and the detector array 24 constitute X-ray irradiation and detection equipment. X-ray irradiation and detection equipment are explained anew later.
[0016] The data collection section 26 is connected to the detector array 24. The data collection section 26 collects the detection data of each X-ray sensing element of the detector array 24.
[0017] The exposure of the X-ray from X-ray tube 20 is controlled by the X-ray controller (controller) 28. In addition, illustration is omitted about the connection relation between X-ray tube 20 and the X-ray controller 28. A collimator 22 is controlled by the collimator controller 30. In addition, illustration is omitted about the connection relation between a collimator 22 and the collimator controller 30.
[0018] The above X-ray tube 20 thru/or collimator controller 30 is carried in the rotation section 32 of the scan gantry 2. Rotation of the rotation section 32 is controlled by the rotation controller 34. In addition, illustration is omitted about the connection relation between the rotation section 32 and the rotation controller 34.
[0019] The photography table 4 carries in and takes out the analyte which is not illustrated to the X-ray irradiation space of the scan gantry 2. The relation between analyte and X-ray irradiation space is explained anew later.
[0020] The actuation console 6 has the central processing unit 60. A central processing unit 60 is constituted by the computer (computer) etc. A central processing unit 60 is an example of the gestalt of operation of the projection compensator of this invention. A central processing unit 60 is an example of the gestalt of operation of the location specification means in this invention again. Moreover, it is an

example of the gestalt of operation of the data correction means in this invention. Moreover, it is an example of the gestalt of operation of the image reconstruction means in this invention.

[0021] The control interface (interface) 62 is connected to the central processing unit 60. The scan gantry 2 and the photography table 4 are connected to the control interface 62.

[0022] A central processing unit 60 controls the scan gantry 2 and the photography table 4 through a control interface 62. The data collection section 26, the X-ray controller 28, the collimator controller 30, and the rotation controller 34 in the scan gantry 2 are controlled through a control interface 62. In addition, illustration is omitted about the connection according to individual of these each part and a control interface 62.

[0023] The capture buffer 64 is connected to the central processing unit 60. The data collection section 26 of the scan gantry 2 is connected to the capture buffer 64. The data collected in the data collection section 26 is inputted into a capture buffer 64. A capture buffer 64 memorizes input data temporarily.

[0024] A central processing unit 60 performs image reconstruction based on the data of two or more views collected through the capture buffer 64. image reconstruction -- for example, a fill TADO back projection (filtered back projection) -- law etc. is used. Storage 66 is connected to the central processing unit 60. Storage 66 memorizes data, various kinds of reconstruction images, programs (program), etc.

[0025] The display 68 and the operating set 70 are connected to the central processing unit 60, respectively. A display 68 displays the information on the reconstruction image outputted from a central processing unit 60, or others. An operating set 70 is operated by the operator and inputs various kinds of directions, information, etc. into a central processing unit 60.

[0026] The typical configuration of the detector array 24 is shown in drawing 2 . The detector array 24 serves as an X-ray detector of many channels which arranged many X-ray sensing elements 24 (i). Many X-ray sensing elements 24 (i) form the X-ray plane of incidence which curved in the shape of a cylinder concave surface as a whole. i is a channel number, for example, is i=1-1000.

[0027] The X-ray sensing element 24 (i) is constituted by the combination of a scintillator (scintillator) and a photodiode (photo diode). In addition, you may be the X-ray sensing element of the ionization chamber mold using for example, the semiconductor X-ray sensing element using a cadmium tellurium (CdTe) etc. or xenon (Xe) gas instead of what is restricted to this.

[0028] The interrelation of X-ray tube 20 and collimator 22 in X-ray irradiation and detection equipment, and the detector array 24 is shown in drawing 3 . In addition, they are drawing showing the condition of having seen (a) of drawing 3 from the transverse plane, and drawing showing the condition of having seen (b) from the side. As shown in this drawing, the X-ray emitted from X-ray tube 20 is fabricated so that it may become flabellate form X-ray beam 40 with a collimator 22, and is irradiated by the detector array 24.

[0029] (a) of drawing 3 shows the breadth of flabellate form X-ray beam 40, i.e., the width of face of X-ray beam 40. The cross direction of X-ray beam 40 is in agreement in the array direction of the channel in the detector array 24. (b) shows the thickness of X-ray beam 40.

[0030] As a body axis is made to intersect the fan of such X-ray beam 40, for example, it is shown in drawing 4 , the analyte 8 laid in the photography table 4 is carried in to X-ray irradiation space. The projection image of the analyte 8 sliced by X-ray beam 40 is projected on the detector array 24. Thickness t of X-ray beam 40 which irradiates analyte 8 is set up by opening accommodation of the aperture of a collimator 22.

[0031] Actuation of this equipment is explained. An operator sets up desired photography conditions through an operating set 70. Subsequently, analyte 8 is scanned with X-ray irradiation and detection equipment under control by the central processing unit 60. By this, the projections of analyte 8, for example, 1000 views, are collected to a capture buffer 64.

[0032] The projection of two or more views collected by the capture buffer 64 forms the two-dimensional view channel space u as shown in drawing 5 . In the view channel space u, a channel number and an axis of ordinate j express [a horizontal axis i] a view number. Moreover, two or more projection data (projectiondata) PRij which stands in a row in the direction of i shows the projection PRj in j view. Projection PRj is an example of the gestalt of operation of the projection in this invention.

[0033] Based on such a projection PRj, for example, by the fill TADO back projection method etc., a central processing unit 60 performs image reconstruction, and generates a tomogram. By this, the tomogram for the analyte 8 as shown in drawing 6 is obtained.
[0034] Inside analyte 8, when there is a body 90 with high rates of X-ray absorption, such as an embedding metal, the streak artifact 92 by it is contained in a reconstruction image. The bodies 90 with the high rate of X-ray absorption may be not only an embedding metal but a bone, a calculus, etc. The body 90 with the high rate of X-ray absorption is an example of the gestalt of operation of the radiation high absorber in this invention.
[0035] When such streak artifact arises, with this equipment, a central processing unit 60 removes the streak artifact as follows. Flow (flow) drawing of the procedure of removing the streak artifact to drawing 7 is shown. As shown in this drawing, the binary image of a tomogram shown in drawing 6 is generated at step (step) 702.
[0036] A binary image sets a pixel (pixel) with the CT number beyond it to 1 by making a proper CT number (number) (for example, 1000) into a threshold, and generates the other pixel as 0. As shown in drawing 8 , the binary image only containing the body 90 with the high rate of X-ray absorption is obtained by this.
[0037] Next, it asks for the sinogram (sinogram) in the view channel space u per body 90 at step 704. In order to ask for sinogram, as typically shown in drawing 9 , two or more projection images of the same view as the time of a scan are searched for about the above-mentioned binary image by data processing inside a central processing unit, respectively by the same geometry (geometry) as the X-ray irradiation and detection equipment at the time of the scan of analyte 8.
[0038] this -- the projection location Pi of the body 90 on i shaft -- each view -- ** -- as it is alike, and is found, for example, it is shown in drawing 10 , the locus SN of the projection location Pi of the body 90 in the view channel space u, i.e., sinogram, can be found.
[0039] In addition, when there are two or more bodies 90, it corresponds for curving and two or more sinograms SN can be found. Also in two or more cases, it is the same although the case where Sinogram SN is single is explained hereafter.
[0040] Next, a projection is amended at step 706. Amendment of a projection is performed by removing thru/or reducing the high frequency component contained in a projection. The portion to amend is specified based on Sinogram SN in that case.
[0041] That is, the projection PRj1 in a view j1 will amend about the predetermined range d including a location Pi, supposing it is shown in drawing 11 and the location of Pi has projection of sinogram SN 90, i.e., a body, on i shaft with this projection PRj1. Range d is appointed suitably. A location Pi is an example of the gestalt of operation of "the correspondence location on a projection" in this invention. By using sinogram, a correspondence location can be pinpointed correctly.
[0042] In amendment, by processing a projection PRj1 with a proper high-pass filter (high-pass filter), it considers as the signal of only a high frequency component as shown in drawing 12 , and asks for the signal strength of each high frequency component belonging to the range d in this, respectively, and these are deducted by those to which a location corresponds in a projection PRj1. The high frequency component of Range d is offset by this (removal).
[0043] Or instead of offsetting each other completely, a proper weighting factor is applied and deducted to each high frequency component, or you may make it reduce each high frequency component by the proper ratio. Thus, it is desirable to use a weighting factor or a ratio coefficient at the point of adjusting the strength of amendment suitably by them.
[0044] Such amendment is performed about the projection PRj of all views, and the high frequency component in the portion corresponding to Sinogram SN is removed thru/or reduced from the projection of all views.
[0045] Next, based on a projection [finishing / amendment], image reconstruction is anew performed at step 708. By this, though the image of the body 90 with the high rate of X-ray absorption is included as shown in drawing 13 , a tomogram without the streak artifact by it can be obtained. The body 90 with the high rate of X-ray absorption is not restricted to a metal, and it cannot be overemphasized that you

may be a bone etc.

[0046] In addition, about any portions other than Range d, since a high frequency component continues being origin also in a projection [finishing / amendment], even if it carries out the above amendments, sharpness of an image is not spoiled. For this reason, amendment of a projection can perform amendment strong enough, without taking into consideration the bad influence to the sharpness of an image. Therefore, the streak artifact can fully be reduced, without spoiling the sharpness of an image.

[0047] As mentioned above, although the example using the X-ray as radiation was explained, radiation may not be restricted to an X-ray and may be radiation of other classes, such as a gamma ray. However, at present, an X-ray is desirable at the point that the practical means is most substantial about the generating, detection, control, etc.

[0048]

[Effect of the Invention] As explained to details above, according to this invention, the radiation tomographic equipment which equipped with such a compensator the projection amendment method of removing the streak artifact by the body with the high rate of the absorption of radiation and equipment, and a list is realizable.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] A projection amendment method characterized by what a correspondence location on a projection of the aforementioned two or more views is pinpointed, respectively per image of a radiation high absorber in a tomogram reconfigurated from a projection of two or more views by radiation, and a high frequency component of said projection in said correspondence location is amended for.
[Claim 2] A projection compensator characterized by providing a location specification means to pinpoint a correspondence location on a projection of the aforementioned two or more views, respectively per image of a radiation high absorber in a tomogram reconfigurated from a projection of two or more views by radiation, and a data correction means to amend a high frequency component of said projection in said correspondence location.
[Claim 3] Radiation tomographic equipment which collects projections of two or more views by radiation characterized by providing the following, and generates a tomogram based on it A location specification means to pinpoint a correspondence location on a projection of the aforementioned two or more views per image of a radiation high absorber in said tomogram, respectively A data correction means to amend a high frequency component of said projection in said correspondence location, and an image reconstruction means to reconfigurate a tomogram based on a projection of two or more views which said data correction means amended

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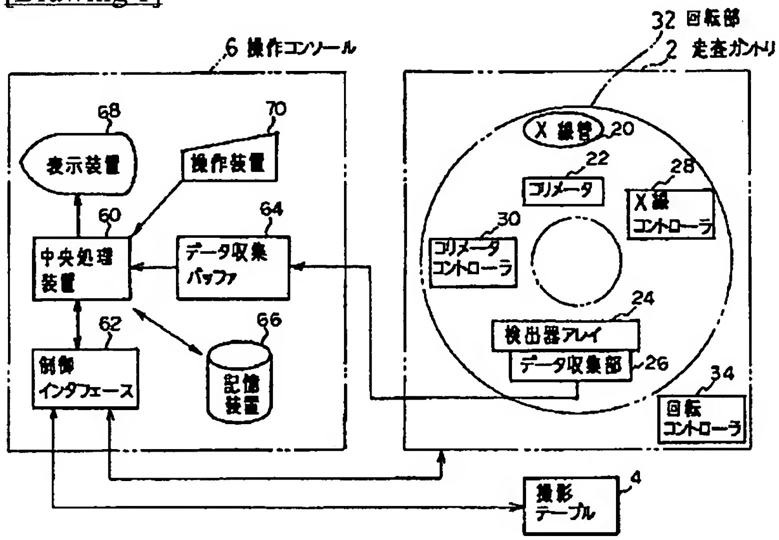
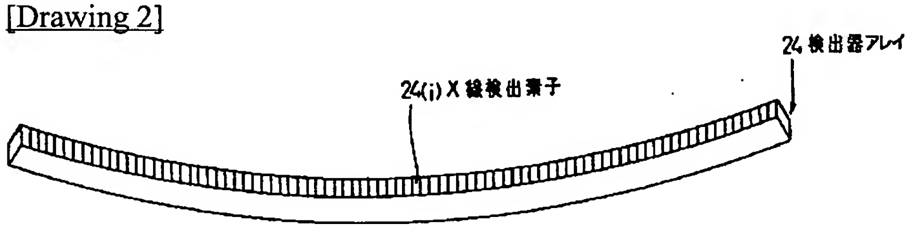
[Translation done.]

DRAWINGS

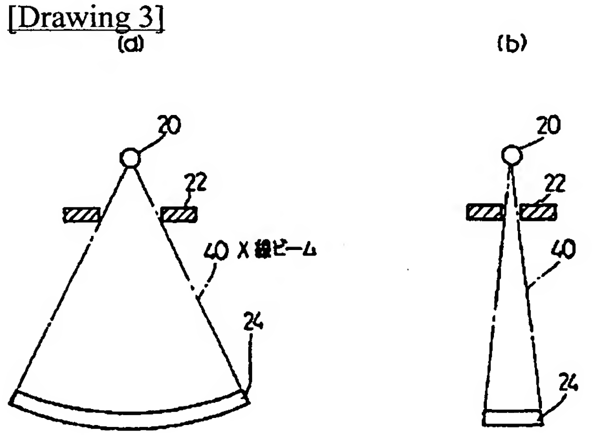
[Drawing 1]



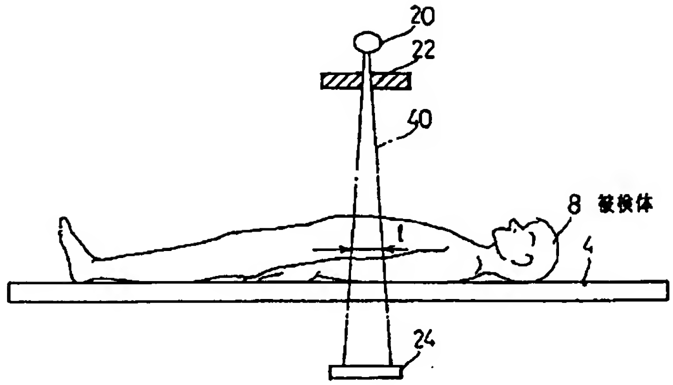
[Drawing 2]



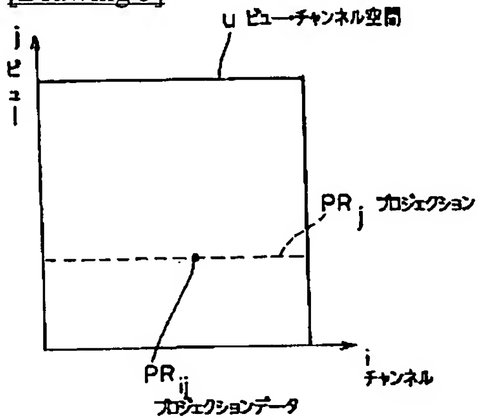
[Drawing 3]



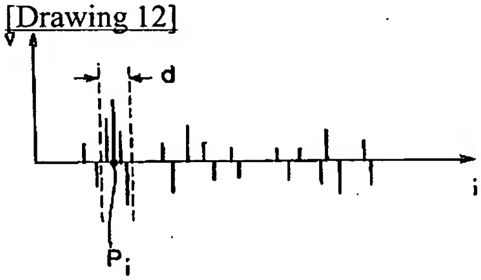
[Drawing 4]



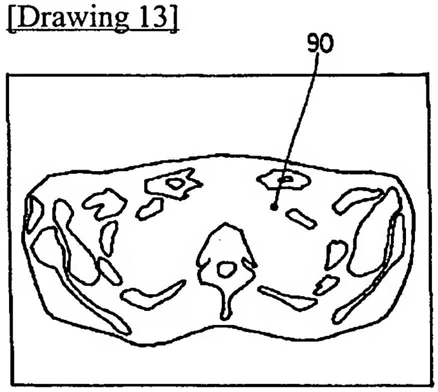
[Drawing 5]



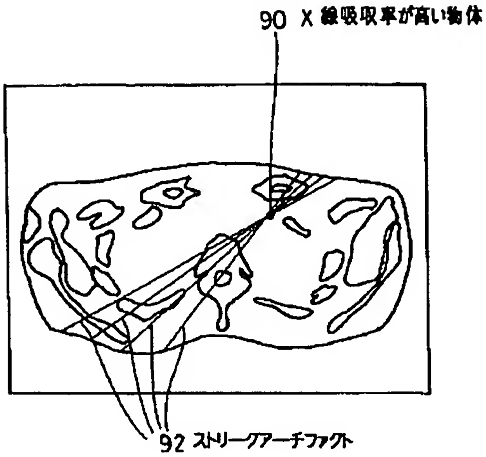
[Drawing 12]



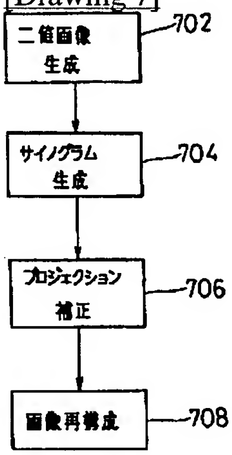
[Drawing 13]



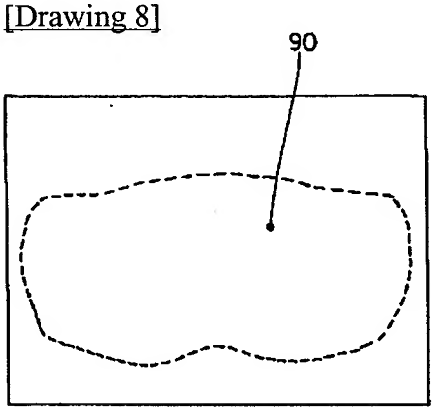
[Drawing 6]



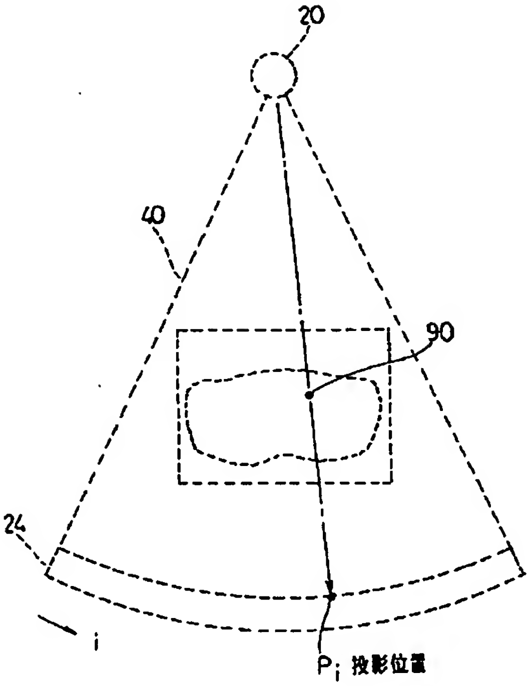
[Drawing 7]



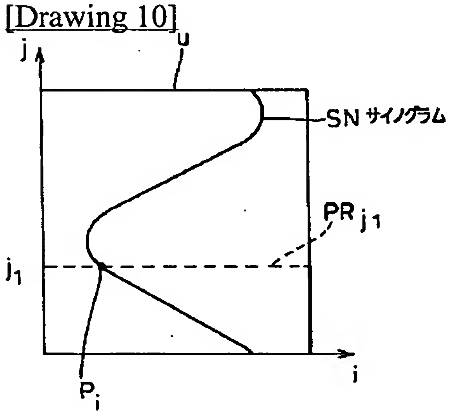
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Drawing 11]